Neutrons Against Cancer

NIU
Institute for Neutron Therapy
at Fermilab

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Unique, Proven Treatment Option

The Northern Illinois University Institute for Neutron Therapy at Fermilab is one of only two sites in the United States offering neutron therapy to cancer patients. Neutron therapy blends advanced medical science with cutting-edge accelerator physics developed at Fermi National Accelerator laboratory, located in Chicago's western suburbs. The neutron therapy clinic at Fermilab has treated more than 3,100 patients and has been in operation longer than any other neutron therapy program in the nation. In 2004, Northern Illinois University assumed management of the facility.

ADVANTAGES OF NEUTRON RADIATION THERAPY

Radiation therapy, also called radiotherapy is the use of penetrating beams of ionizing radiation for the treatment of cancer. Fast neutrons are one type of radiation used and, for certain types of cancer, offer improved benefits over other types of radiation therapy such as photons (x-ray), electrons, protons and other heavy particles.

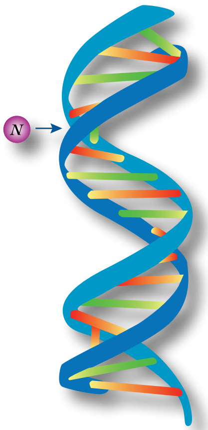
The basic effect of ionizing radiation is to destroy the ability of cells to divide by damaging their DNA strands. One measure of this destructive ability is called linear energy transfer (LET). Fast neutrons are high LET radiation and the damage is done primarily by nuclear interactions. Photons, electrons and protons are low LET radiation and their damage is done by activated radicals produced from atomic interactions.

If a cancer cell is damaged by low LET radiation it may repair itself and continue to grow. With high LET radiation, the chance for a damaged cancer cell to repair itself is very low.

In general fast neutrons can control large tumors because, unlike low LET radiation, neutrons do not depend on the presence of oxygen to kill the cancer cells. In addition, the biological effectiveness of neutrons is not affected by the stage in the life cycle of cancer cells as it is with low LET radiation.

Because of the high biological effectiveness of fast neutrons, the required dose of neutrons to kill the same number of cancer cells is about one third the dose required with low LET radiation. A full course of treatment consists of 12 treatments, three times a week for four weeks, compared to 30-40 treatments, five times a week for six weeks with photons, electrons, or protons.

Neutron radiotherapy is offered at Northern Illinois University Institute for Neutron Therapy at Fermilab (NIUINT). Physicians staffing the clinic are members of the Nuclear Oncology Service Corporation. Other medical staff members are employees of Northern Illinois University and Fermilab.



A schematic showing the structure of DNA.

Neutrons kill cancer cells by destroying their DNA.

NIU INSTITUTE FOR NEUTRON THERAPY AT FERMILAB

Fermilab operates the most powerful particle accelerator in the world. It was built for high-energy physics research. The cancer treatment at Fermilab is possible because Fermilab's linear accelerator (Linac) provides beam for both high energy physics research and neutron radiation therapy.

NIUINT at Fermilab has the highest-energy clinical fast neutron beam in the United States. This beam has the best tissue-penetrating ability and, therefore, the best capability for treating deep-seated, large tumors.

An isocentric system is used to adjust the patient's position between exposures. Each exposure to the beam lasts from one to three minutes. There is no pain involved in the treatment process. During treatment the patient is observed via closed circuit television, and communication is maintained by an intercom system.

CLINICAL EFFECTIVENESS

Clinical trials comparing neutrons with photons were conducted for ten years to determine which cancers could be better treated with fast neutrons. The types of cancer studied are classified as "radioresistant"; that is tumors which do not respond well to low LET radiation. The clinical trial results showed that salivary gland tumors of various histopathologies, classified as radioresistant, are better controlled by fast neutrons. Examples of salivary gland tumors include adenoid cystic, acinic cell, squamous cell, mucoepidermoid, adenocarcinoma as well as malignant pleomorphic adenoma.

Fast neutron beam therapy has also been shown to be more effective in soft tissue and bone sarcomas such as liposarcoma, leiomyosarcoma, fibrohistiocytoma, synovial sarcoma, chondrosarcoma and osteogenic sarcoma. In addition, clinical research has shown that fast neutron therapy is superior to photons in high-grade, locally advanced prostate cancers.

Fast neutrons may also be used in other cancer types such as unresectable pancreatic, adenocarcinoma/mesothelioma of the lung, and malignant melanomas. Fast neutron therapy can be used to alleviate local symptoms such as pain or bleeding in cancers that have spread from the above sites.

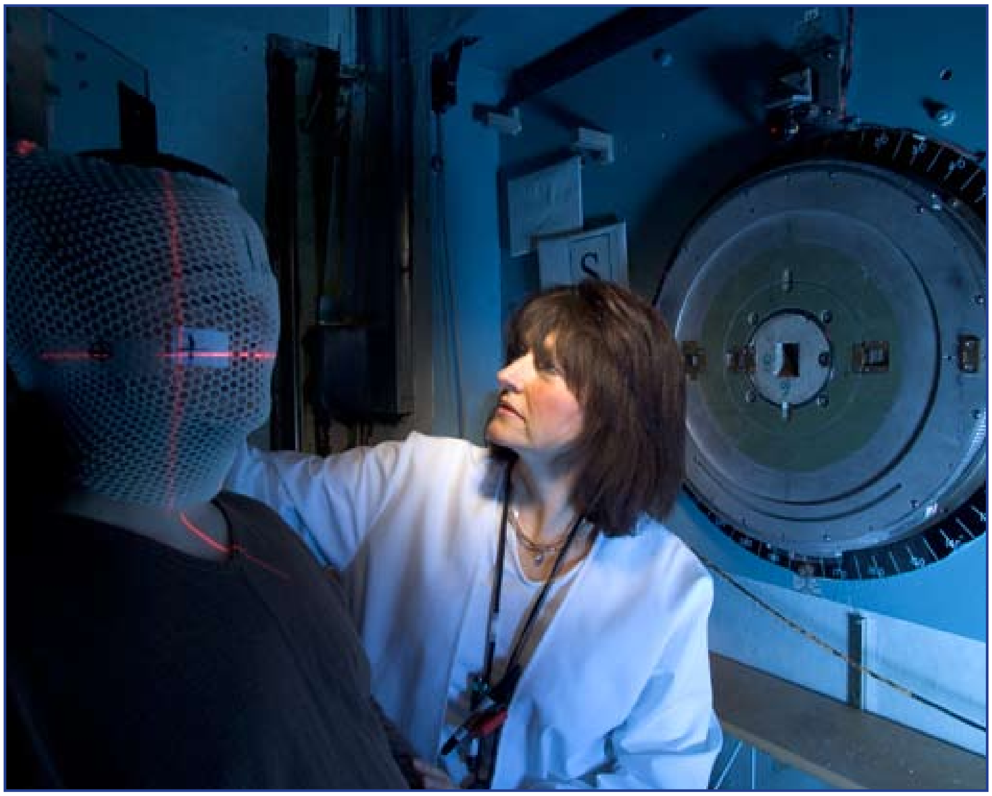
Patients are assessed by oncology nurses during the course of treatment.

Side Effects

Acute side effects for fast neutron therapy are similar to those of low LET therapy. The severity depends on the total dose delivered and the general health of the patient. Careful, computerized treatment planning minimizes effects on normal tissues. Most of the acute side effects are temporary and normal tissue recovery occurs with time. Some permanent late effects may be anticipated. Possible side effects related to their particular treatment site are discussed with patients before treatment begins. The medical staff works closely with patients and families to provide assistance in managing side effects that might occur during and following completion of treatment.

Adenoid Cystic Carcinoma pre and post neutron treatment.

Treatment plans are developed and reviewed by radiation oncologists and medical physicists.



Patients are prepared for treatment by radiation therapists.

HISTORY OF NEUTRON THERAPY

Sir James Chadwick discovered neutrons in 1932. Just six years later, Dr. Robert Stone began clinical trials treating cancer with neutrons produced by E.O. Lawrence's cyclotron in Berkeley, California. These trials were terminated because the cyclotron was needed for the war effort during World War II. Clinical research began again in 1965 when Dr. Mary Catterall at Hammersmith Hospital in London began irradiating patients with neutron beams. By 1969, it was clear that for certain tumors, better local control could be achieved using neutron irradiation. Encouraged by these results, the M.D. Anderson Hospital and Tumor Institute in Houston, the Naval Research Laboratory in Washington, D.C., and the University of Washington in Seattle began neutron therapy research. They started treating patients in the early 1970s. During the mid-1970s Chicago-area radiation oncologists, Lionel Cohen, M.D. and Frank Hendrickson, M.D., worked with Dr. Robert R. Wilson (Fermilab Director from 1968 until July 1978) to build the Neutron Therapy Facility (NTF) at Fermilab. Measurements of neutron beam characteristics and dose distributions were completed in 1976; patient treatments were begun September 7, 1976.

The National Cancer Institute funded the operation of the facility from June 30, 1975, until October 1, 1985. During that period NTF conducted clinical trials to determine the appropriateness of using neutrons to treat various types of cancers. Initial research included using different doses in order to determine the optimum, safe therapeutic dose with minimum treatment-related late side effects. Some of the trials involved randomly assigning eligible patients to receive either the best conventional treatment for their cancer, or neutrons, which at the time were considered to be experimental. This was done only with the patient's permission. Fermilab's treatment results using a high-energy neutron beam were combined and analyzed with the results from other facilities.

Former patients celebrate NTF's 25th anniversary.

TREATMENT PROCESS

The treatment process includes consultation, treatment planning, and 12 treatments, 3 per week for 4 weeks. The average daily treatment process is 30 minutes including set-up.

COST

Total charges for a course of neutron therapy are about the same as the charges for a course of photon therapy. Medicare and most insurance providers cover neutron therapy.

REFERRALS

A physician may refer patients for therapy or individuals may call NIUINT directly. Radiation Oncologists will determine whether or not neutron therapy is appropriate for a particular patient. After the course of treatment is completed, patients are encouraged to return to NIUINT for regularly scheduled follow-up examinations. Working closely with referring physicians, the staff will coordinate the therapy and follow-up visits.

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